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SOME NOTABLE INSTANCES OF THE DISTRIBUTION OF INJURIOUS INSECTS BY ARTIFICIAL MEANS

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SOME NOTABLE INSTANCES OF THE DISTRIBUTION OF INJURIOUS INSECTS BY ARTIFICIAL MEANS

By FRED. V. THEOBALD, M.A.

Vice-Principal of the South-Eastern Agricultural College; President of the Association of Economic Biologists of Britain; Foreign Member of the Association of Economic Entomologists, U.S.A.; etc.

One of the most noticeable phenomena amongst the insects injurious to fruit, farm and garden crops, stores, man and his domesticated animals, is the almost world-wide distribution of certain of these pests. That this distribution is not a natural one we may safely infer from what we know of the general range of insects. Some species spread over a very wide area naturally, such as the Cotton Boll Worm (*Heliothis obsoleta*, Fabricius), which is found in Europe, Africa, and America; the Army Worm (*Leucania unipuncta*, Haworth), which is common to both hemispheres; and the Migratory Butterfly (*Danais archippus*). Such instances are comparatively few in number. In spite of these, we can say definitely that there is no insect really cosmopolitan by nature. Just as with birds and other animals, so with insects—each species has a definite area of distribution. Many may increase this area by natural means, as we see has taken place with the Mexican Boll Weevil (*Anthonomus grandis*, Boheman), and the Colorado Beetle (*Doryphora decemlineata*, Say.), but only within certain limits. Hence when we find some insects that attack plants, man, or animals almost world-wide in distribution, we may be sure that their range is due to some artificial cause or causes. On studying this subject we can at once see how easy it is for certain pests to be carried over the face of the earth by man's agency.

This distribution takes place by means of boats and trains and all other ways of intercourse. The more rapid these means of communication become, the more likely we are to see a concomitant increase and spread of many injurious insects, unless checked by stringent regulations. This dispersal has

taken place mostly from north and south towards the Equator. We find that many temperate-climate insects will live and flourish in sub-tropical and tropical climates, but the reverse only applies within certain narrow limits according to each species.

It is extremely unlikely that many tropical pests would live and flourish in the warmer climates of Europe, although we have an instance of such in the Yellow-fever Mosquito (*Stegomyia fasciata*, Fabricius). On the other hand, sub-tropical species may do so, and even penetrate into still more temperate regions—as, for instance, the San José Scale (*Aspidiotus perniciosus*, Comstock), which is found spreading as far north as Canada. The Yellow-fever Mosquito (*Stegomyia fasciata*, Fabricius), however, does not seem to occur farther north and south of the Equator than 48°. It has evidently spread outwards from the Central American States. We also see that the Brown Spotted-Mosquito (*Theobaldinella spathipalpis*, Rondani) has spread from Europe to the Sudan, and also far into the Cape.

Of wider distribution still are some insects which attack stored goods. We find the Corn and Rice Weevils (*Calandra granaria* and *Calandra oryzæ*, Linnæus) now in almost all countries from the Equator to Norway and New Zealand, because they are so easily carried in grain.

The manner in which an introduced insect may behave in a new country cannot be foretold. It may increase very rapidly, such as did in California, the Cottony Cushion Scale (*Icerya purchasi*, Comstock), which came from Australia. On the other hand, it may die out sooner or later, as happened with the Tasmanian Lady-birds (*Leis conformis*), which I introduced into this country. The Cushion Scale found a comfortable home and there being none of its natural enemies to prey upon it, the Scale increased at an enormous rate. The Tasmanian Lady-birds, although they survived two seasons, found the climatic conditions unsuited to them, and consequently died out.

Many insects from the tropics and sub-tropics may be imported to temperate climates, such as our own, and will flourish under glass, where they find congenial heat and moisture. Scale insects, or *Coccidæ*, are particularly prone to do so. Most of the palm- and hot-house Scale insects we have in Britain are foreign importations. Only recently a Mealy Bug

(*Dactylopius nipæ*, Maskell) new to Britain has been sent to me on palms from Blackheath. It was originally described from Demerara, and has also occurred at Bournemouth in Hampshire.

The introduction of injurious insects can only be stopped by legislation. We find that most of the countries of the world have regulations protecting them from foreign importations, such as "An Act to prevent the introduction and provide for

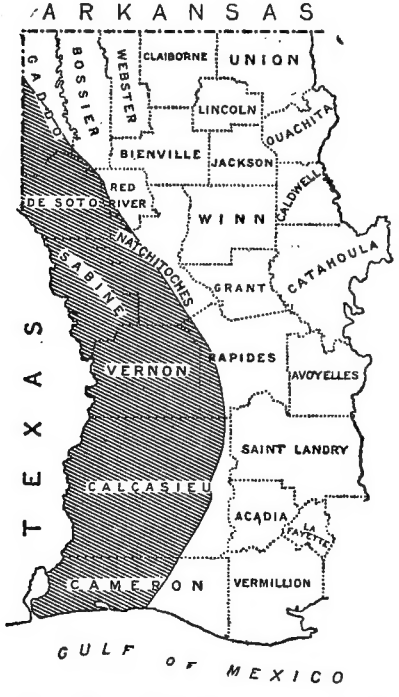

FIG. 1.—Area in Louisiana infested by the Cotton Boll Weevil in December 1904 (after Newell).

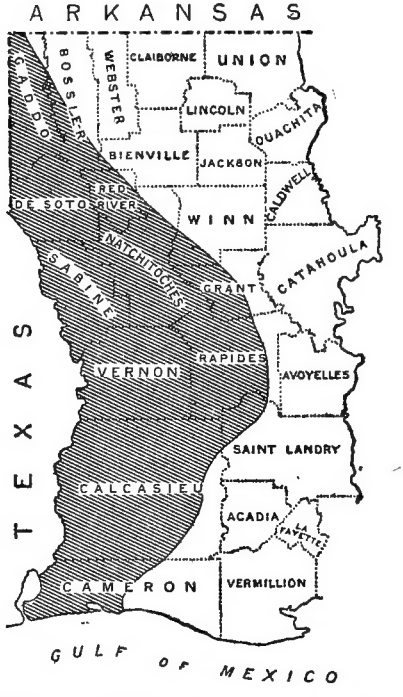

FIG. 2.—Area in Louisiana infested by the Cotton Boll Weevil in November 1905 (after Newell).

the eradication of disease affecting orchards and gardens" in New Zealand.

We may also get greatly increased local distribution by natural methods. As an instance of rapid natural distribution, we may mention the Cotton Boll Weevil. The beetles migrate in definite directions, and at certain times of the year. How great this distribution may be we can best judge by a glance at the figures showing the range of this serious cotton pest in Louisiana in 1904 and 1905 (figs. 1 and 2).

First, we will consider insects that attack fruit-trees in orchards and gardens, which may easily be carried from one country to another over sea, or from one state to another over land. The following are some of the most important in this category:[1]

The Codling Moth (*Carpocapsa pomonella*)*; the Bud Moth (*Tmetocera ocellana*)†; the Pith Moth (*Laverna atra*); Pistol and Cigar Case-Bearers (*Coleophoridæ* spp.); Bagworms (*Thyridopteryx*, etc.); Lackey Moths (*Clissiocampidæ* spp.); the Peach Borer (*Ægeria exitiosa*, Say.); and Currant Borer (*Ægeria tipuliformis*, Linn.); the Shot-borer Beetles (*Xyleborus dispar*, etc.); Bark Beetles (*Scolytus rugulosus* and *S. destructor*, etc.)†; Currant Sawflies (*Nematus* spp.); the Pear Slugworm (*Eriocampa limacina*). Various fruit flies, such as the Apple Fruit Fly (*Trypeta pomonella*)†; the Mediterranean Fruit Fly (*Ceratitis capitata*); the Australian Fruit Flies (*Dacus tyroni*, etc.); and the Indian Fruit Fly (*Dacus ferrugineus*). Psyllidæ, such as the Apple Sucker (*Psylla mali*) of Europe and the Pear Sucker (*Psylla pyri*) of America; the Woolly Aphis (*Schizoneura lanigera*)†; the Currant-root Louse (*Schizoneura fodiens*); the Phylloxera or Vine Louse (*Phylloxera vastatrix*). Various aphides of all kinds, such as the Cherry Aphis (*Myzus cerasi*); Apple Aphides (*Aphis pomi*, *A. fitchii*, and *A. sorbi*). Of scale insects or Coccidæ, the most important are the Mussel Scale (*Mytilaspis pomorum*)*; the San José Scale (*Aspidiotus perniciosus*); the Japanese Cherry Scale (*Diaspis amygdali*)†; the Peach Scale (*Aspidiotus persicæ*); the Cottony and Egyptian Cushion Scales (*Icerya purchasi* and *I. ægyptica*); and very many Citrus Scales, such as *Aspidiotus aurantiæ* and *Mytilaspis citricola*.

Besides true insects we get the ova of Red Spiders (*Bryobia pretiosa*); various gall-mites or Eriophyidæ, such as the Currant-bud Mite (*Eriophyes ribis*) and the Pear-leaf Blister Mite (*Eriophyes pyri*).

These various pests may be carried in three different ways—namely (1) in and on fruits and seeds; (2) on living plants; and (3) in the cases and packages in which fruits and plants are sent. It will at once be said that the first and last are of little importance, as such cases of fruits are taken to large towns and markets.

[1] Those marked with an asterisk come in abundance to Britain; those with a dagger may do so now and again.

But they *are* very important, for these cases are distributed from the central markets to stores in small towns and villages. The stores, especially of the latter, are frequently close to gardens and even large orchards. Thus the pests that come over with the fruit may easily reach trees and bushes near by, either by flying or crawling, or by being carried by birds, other insects, or by man. Where the pests in the fruit are active insects, they often crawl to the baskets, that home-grown fruit is sent to the market in, for shelter. In this way many insects are carried back to our plantations, and many insect enemies have thus been spread over the earth. Nursery stock has also played, and does still, an important part in distributing diseases.

The most important insect spread by means of fruit is the Codling Moth (*Carpocapsa pomonella*). Originally this apple pest seems to have come from Europe. Its life-history is too well known to recapitulate fully here. Suffice it to point out that the larvæ, or maggots, occur in the fruit at all stages. When they are quite young they do not show any very marked symptoms of attack; but a careful examination will always reveal the presence of a small quantity of brown "frass" around the "eye," a sure sign of the maggots' presence. The larvæ always leave the fruit when full grown to pupate in convenient shelter, which is normally found under the bark of apple trees. They leave the fruit just the same when it has been picked, and then seek shelter in store-rooms and in the cases and barrels in which the apples are dispatched. Failing this, they will leave the barrels in large numbers when opened and seek shelter elsewhere, such as in market baskets near by. In the latter way they are conveyed to the country. Quite exceptionally the maggots may be carried with nursery stock, they having spun their cocoons in some fork of the branches. That the Codling Moth is sent in numbers from country to country any one can verify for himself by examining apples imported into this country when the barrels are opened in the markets. It must not be imagined that *all* apples come thus infested. I have not detected any in Tasmanian apples, but have very frequently in American and Canadian. Perhaps most occur in the shipments of Portuguese and Madeira fruits. The result of this means of transit has been that we now have the Codling Moth not only all over Europe, but in America, Canada, Madeira, Teneriffe, Cape Colony, Australia, and New Zealand.

The amount of damage done by it must be millions of pounds a year in the collective countries.

Fortunately, many of our colonies are alive to the importance of this subject. The Codling Moth Act of Tasmania, passed in 1884 and amended in 1891, has been so far successful that the colony is now almost free of this pest. All possible steps are taken to prevent its importation.

Natal has also legislated concerning the importation of this and other fruit pests. An Act (Law 15) was passed in 1881 "To regulate the introduction in this country of plants or cuttings which by reason of disease or otherwise might be injurious to the interests thereof." The benefit of this legislation we see in the case of the Codling Moth. Natal is one of the few countries where apples are grown in which the Codling Moth does not occur. It has been said to do so, but I am informed that these statements are erroneous. Mr. Fuller, the Government Entomologist, has shown that the diseased apples have been attacked by Fruit Flies.

Why is this? Simply because, under the Act referred to, a proclamation (79, 1897) was made prohibiting the introduction of all plants, portions of plants, cuttings, and anything taken off or from apple trees in the island of Madeira. Later, all diseased apples were prohibited coming from any region. Under these powers we find that in September 1903 seventy-five cases of Portuguese apples were destroyed; in September 1904 thirteen baskets of apples from Madeira were immediately reshipped on account of this pest. As a result, the colony is kept free from one of the most insidious apple and pear enemies the grower has to put up with.

The same is done in New Zealand, where 2,257 cases of apples were destroyed in 1901. In 1904 we find that the authorities in the Hawaiian Islands, acting under legal powers, destroyed all infested apples sent there.

It is almost useless to deal with this insect in a country unless protection is given from invasion from without.

The other important insects distributed in fruit are the numerous species of Fruit Flies (*Trypetidæ*). Different species attack a great variety of fruits, such as apples, pears, peaches, citrus fruits, guavas, bananas, etc. There are three genera that are destructive as Fruit Flies—namely, *Dacus*, *Ceratitis*, and *Trypeta*. The former has clear wings with one or two dark

lines, and has been wrongly referred (so I am informed by Mr. Austen, Dipterologist at the British Museum, by Mr. Froggatt and others in Australasia) to the genus *Tephritis*; *Ceratitis* has ornamented wings with a dense fine network of veins at the base; whilst the last named has mottled wings with normal venation. These Fruit Flies lay their eggs in both sound and rotting fruits; the maggots live in the pulp, and can at once be told from Codling Maggots by being apodal. Numbers are frequently found in a single struck fruit.

The great importance of these pests cannot be overestimated, as we have no remedy for them. All that can be done to guard against Fruit Flies is to protect the trees by means of muslin tents, an operation too costly to be carried out in most places.

That these insects have been and are still imported with the fruit we know quite well. The Mediterranean Fruit Fly (*Ceratitis capitata*) has thus been distributed into Australia and Cape Colony and elsewhere, and has become a serious pest in its new homes. The various Australian Fruit Flies (*Dacus tryoni*, Froggatt) and others are found in numbers in exported fruit. As a result, New Zealand prohibits all fruit infested with Fruit Flies from being landed. We find in the official records that 3,700 cases of fruit were destroyed in 1901 on account of the presence of these enemies.

Similarly, St. Helena has passed an Ordinance (1904) prohibiting the importation of all fruits from South Africa, Mauritius, Cape Verde, and Malta, and for the extermination of the Peach Fly (*Ceratitis capitata*).

Neither *Ceratitis* nor *Dacus* are likely to flourish here, if imported; but they may do so in many warm countries where they are not yet known as pests, and might even exist in hothouses here.

We find these insects also in Mexico and many other countries. During 1904 many cases of fruits were destroyed at the Hawaiian Islands on account of the presence of Mexican Fruit Flies. Recently they have been found attacking melons in the Sudan (*Dacus* sp. ?).

One species may easily be imported into Britain—namely, the Apple Fruit Fly of America (*Trypeta pomonella*, Walsh). I feel confident some apples sent me from the Isle of Thanet were attacked by this pest; but, unfortunately, the dipterous larvæ

did not hatch out. Should it appear in this country, it would prove another serious enemy in our already much-smitten orchards, and *we* have no law to prevent any such incursion.

Scale Insects, or *Coccidæ*, are also largely distributed on fruit, the majority on citrus fruits, but many on other kinds. We find amongst these the Red Scale (*Aspidiotus aurantiæ*), the San José Scale (*Aspidiotus perniciosus*), and the Mussel Scale (*Mytilaspis pomorum*).

The Mussel Scale occurs most abundantly on apple and pear, but also on many other plants, both cultivated and wild, such as thorns, in this country. By means of imported stock and fruits this insect has become almost world-wide in distribution. It is now found in Cape Colony, Natal, Egypt, all over America, Australia, and New Zealand, as well as in Europe, which is probably its original home. This Coccid is found on trunks, boughs, leaves, and fruit. It is not so often seen on the fruit in this country, but it comes over from abroad in large numbers in this way on apples, pears, etc. The great difficulty of keeping the Mussel Scale in check is well known, as it lives on wild as well as cultivated plants. Moreover, it is difficult to kill, except with strong paraffin emulsion; hence it is very important to keep it from entering a country or district where it does not occur. This can only be done by absolutely prohibiting any plants infested with it. Fumigation with hydrocyanic acid gas, I have found, has no effect upon the egg stage. When trees are lifted for removal or export, the scale is usually found in this condition. I do not think it is yet found in Central, Eastern, or Western Africa, so these areas should guard against its introduction in no uncertain manner.

The danger of introducing a scale insect is best seen in the case of the White Cushion Scale (*Icerya purchasi*, Comstock). This insect was imported into America from Australia. Its rapid increase, with such disastrous results to fruit-growers, is now a matter of history; and also its subsequent check by bringing over its natural enemy from Australia—the Lady-bird (*Vedalia cardinalis*). We now have this Icerya working in other places, notably in Egypt, in company with an allied species (*Icerya ægyptica*), and also in Portugal.

The San José Scale (*Aspidiotus perniciosus*, Comstock) is perhaps most feared of all Coccidæ. Its original home cannot

be said to be definitely known. Most probably it came from Northern China, where it has been recognised so long that there is no record of its origin. It did not call for much comment there, because it was held in check by its natural enemies. The introduction of one of these enemies (a lady-bird beetle) into America has not had the same good results as the Australian Vedalia, partly because the beetles themselves were attacked by a parasite.

The actual introduction of the San José Scale into America seems to have been made from Japan, on some Japanese plums sent to California with the hope they would prove Curculio-proof. From California it was sent with nursery stock to Pennsylvania in 1890 and 1891, and also to Virginia and a few other Eastern States. From that time it has gradually spread over America until it now does millions of dollars' worth of damage every year. So important is this pest that not only most of the American States, but most of the European countries, have laws safeguarding them against its introduction—even Turkey. Britain stands alone in not fearing the advent of this pest! There is no reason why it should not flourish in the West of England just as it does in Canada. It occurs also in Australia. Not only may it be spread by means of nursery stock, but also on fruit, especially apples and pears.[1] It also infests countless hardy plants, trees, shrubs, and vines.

Thus in three ways we see how insects have been spread from one country to another by artificial means—namely, on stems of plants, in and on fruit, and in packages. There is yet a fourth way—namely, on the roots.

The Woolly Aphis (*Schizoneura lanigera*), or, as it is wrongly called, the American Blight, not only lives on the trunk and twigs of apple and pear, but also on the roots, where it produces galls of a similar form to those above ground. This woolly aphis lives during winter in two ways—(1) as active insects hidden in crevices in the bark, both above and below ground, and (2) as eggs, which are few in number and which are placed close to the base of the stem. It is extremely difficult to see a few of these insects or ova during the winter, when they are hidden away. As no steps were taken formerly to check insect introduction into our colonies and America, it is not surprising to find this Schizoneura wherever apples are grown. It abounds

[1] This is doubted by many of the chief authorities in America.

in the United States and Canada, it is very common in Australia and in New Zealand, and we find it in Natal and in Cape Colony, as well as all over Europe, from north to south.

The Phylloxera is another root-form which has been spread artificially over the face of the earth, carrying ruin with it throughout the vineyards. The Vine Louse also seems to be an European insect, and has been spread to America, Australia, the Cape, etc., with vine plants and cuttings. With this vine pest we get, as in the Woolly Aphis, a subterranean and an aerial race, and it is probably on the roots that it has been distributed so widely. Every country save our own has some Act or Ordinance forbidding the entry of vines, cuttings, etc., from foreign countries, or else limiting the introduction in certain drastic ways.

Another European Phylloxera (*Phylloxera corticalis*) which attacks oaks in Europe has recently been found in South Africa doing considerable damage. It has doubtless been introduced with seedling oaks.

Many Aphides have been spread on fruit trees and plants. One that has the widest distribution is the Black Fly of the Cherry (*Myzus cerasi*), which is now found in America, Australia, New Zealand, and South Africa, as well as all over Europe. The small black eggs of this aphis are not at all easy to detect on young cherry trees. Thus they are easily passed unnoticed with nursery stock into new areas. Living aphides may also be imported from some distance. A consignment of strawberries from England were examined (as all imported stock is) on arrival at Durban, and all the plants were found to have many living aphides upon them. Had there been no fumigating regulations in vogue, a serious pest would have been introduced into the colony which previously did not exist. The Apple Aphides (*Aphis mali*, *A. sorbi*, and *A. fitchii*) common to Europe and America doubtless were imported from one country to another with nursery stock many years ago.

The earth around the roots of plants must also bear its quota of insect enemies, for we find the Pear Midge (*Diplosis pyrivora*) in a few localities in America. It cannot have entered in any other way. We know that the larval midges fall from the fruitlets when they are mature and pupate in the soil. These puparia are very small, and are easily overlooked. Mixed up with particles of earth that stick to the roots, they may easily

be carried over land and sea for any distance. It is surprising that this pest has not made its way to other parts than America before now.

In a similar way we can account for the wide distribution of the Pear and Cherry Sawfly, or Slugworm (*Eriocampa limacina*), which exists in America and Cape Colony. The Slugworms pass the winter in small earthen cocoons in the soil. They are often very abundant on nursery stock, and some cocoons are sure to be lifted with the stock and may remain attached to the roots with small clots of earth. Taken to a fresh country, they will hatch out in due course, unless the roots are previously treated.

As there is no doubt about the dispersal of such pests on rootage, it is very important that all imported stock should have the roots well cleansed before being planted. This is, I fancy, a point generally overlooked, but one of great importance in the artificial distribution of insect enemies.

Just as with hexapods, so with Eriophyid mites. These minute acari, formerly known as *Phytoptidæ*, live either in buds alone, as we see happens with the Big Bud Mite of the Currant (*Eriophyes ribis*, Nalepa), or in galls formed on leafage and blossom, as in the Pear-leaf Blister Mite (*E. pyri*, Sch.) and the Cotton Mite (*E. gossyperi*) respectively. In the pear pest the winter is passed in the buds, and the same applies to those that gall the leaves of the plum. It is extremely difficult to detect the presence in winter buds of the leaf-living forms, as the invaded buds do not swell. On the other hand, we all know the well-marked, swollen appearance of the "Big Bud" attack in black currants. It is not surprising, therefore, to find that the pear phytopt has a wide distribution. The Pear-leaf Blister Mite (*Eriophyes pyri*) is now found in America, Canada, and in Cape Colony. There is no doubt that it has been imported into all three countries with nursery stock, grafts, etc.; but we have no evidence showing when this took place. In some of its new environments this mite seems much more destructive than it is in its original home.

The Big Bud Mite of the Currant (*Eriophyes ribis*) so far does not occur outside Europe, but its distribution there has increased very rapidly. No natural causes can account for it. On the other hand, we can do so by the distribution of infested stock. That this has taken place in a most persistent manner for some

years we know. Some growers at one time even maintained that the "Big Buds" were signs of increased vitality. The importation of such diseased plants into any new district has always been followed by the disease spreading out around the infected plantation by natural means. The minute acari are carried about by bees and birds. They are also spread artificially around an infested plantation by means of the baskets in which fruit is picked, by the clothing of the pickers, and even with the mud on people's boots.

The Colorado Beetle (*Doryphora decemlineata*, Say.) has been distributed artificially to this country, and there is not the least doubt that if it had not been rigorously stamped out by the authorities of the Board of Agriculture, acting under the Colorado Beetle Order of 1877, it would have spread to a disastrous extent. First it was found breeding luxuriously in Tilbury Dockyard in 1901, and continued until 1902, in spite of most drastic measures. In the latter year it was effectually stamped out.

The spread of this beetle by natural means has been remarkable. Originally it lived on wild solanaceæ in the Rocky Mountains; but as settlers pushed forward with their patches of potatoes, the beetles left the wild plants for the cultivated, and so spread farther and farther afield until now it is found flying in the neighbourhood of New York, and has even been seen in the city. How it was conveyed to England we do not know, but probably some specimens flew on to a ship and left it again on arrival at Tilbury.

The Hessian Fly (*Cecidomyia destructor*, Say.) is another instance showing the great harm caused by the introduction by artificial means of an injurious insect into a new country. There is plenty of evidence to show that this corn pest is European in origin. It attacks not only cultivated graminaceæ, but also wild kinds. We hear, for instance, of it devastating "twitch" or "couch" grass in Siberia. We know it occurs on the same and on other grasses in Britain. One heard so much of the Hessian Fly in the papers in 1891 that one was brought to believe that it had been imported into this country from America. In reality the insects were imported into America with straw by the hired Hessian troops, and first took up their abode at Long Island, and have gradually spread over the greater part of the wheat-growing areas of North America.

Thus again we find great damage done by an introduced insect. In England it never will be a very serious pest, because the chief damage it does is to autumn-sown corn, which in America is sufficiently up to allow of attack by the second brood, but with us a second brood would die off before the seed had germinated. This pest may be disseminated in two ways—one on the straw, as we see happened in regard to America, and another with seed corn, for some of the puparia may be found in it, although most come away in the "tailings."

Here again we find that somehow the natural enemies were not imported with the pest into America. For with us and in Russia the puparia are frequently found parasitised by chalcid flies to such an extent that one breeds out often more parasites than flies in this country; hence it is kept in check with us.

The Wheat Midge (*Diplosis tritici*) of Europe, also found in North America, doubtless owes its origin there to similar factors.

Of the pests of animals we may still more expect to find a wide distribution due to artificial causes.

The Sheep Scab Mite (*Psoroptes communis*, var. *ovis*, Fustenberg) has undoubtedly been spread to all sheep-farming countries with the imported stock. Thorough quarantining would have prevented this, such as the regulations which are in force in most countries now concerning the introduction of animals. We can see similar results in regard to the insect enemies of stock. The Sheep Nasal Fly (*Œstrus ovis*), which lives in its maggot state in the nasal cavities and sinus of the sheep, has been spread with the sheep, and we now find it in America and Australia. The same has happened with the Ked (*Melophagus ovinus*).

Of all human injurious insects the Mosquitoes, or *Culicidæ*, stand foremost in this subject of artificial distribution. This is not so much so on account of the great importance they are to man as annoying agents and as the means of conveying such diseases as yellow fever, malaria, filariasis, and dengue fever, as on account of the wide knowledge we have of their distribution, and the means by which they have been and still are spread over the globe. It is only natural to expect that those with a wide distribution are intimately connected with man; such is what we find to be the case. It is those which we may class as domesticated mosquitoes which we find have a wide range. The three most noticeable are the Yellow Fever Carrier (*Stegomyia*

fasciata, Fabricius), the Household Brown Mosquito (*Culex fatigans*, Wiedemann), and the Brown Spotted-Mosquito (*Theobaldinella spathipalpis*, Rondani).

The Yellow Fever Carrier (*Stegomyia fasciata*) is commonly called the "Banded" or Tiger Mosquito. It occurs in the following countries: *Europe*—in Spain, Portugal (south), Southern Italy, Greece, the Mediterranean Islands; *Asia*—in India, the Malay ports, China and Japan; *Africa*—in Natal, Transvaal and Orange River Colonies, in Rhodesia, Uganda, on both east and west coasts, in Egypt and up the Nile past Khartoum, in Algeria and Tunis; *North America*, in the central and southern States, and, as we proceed south, still more abundantly

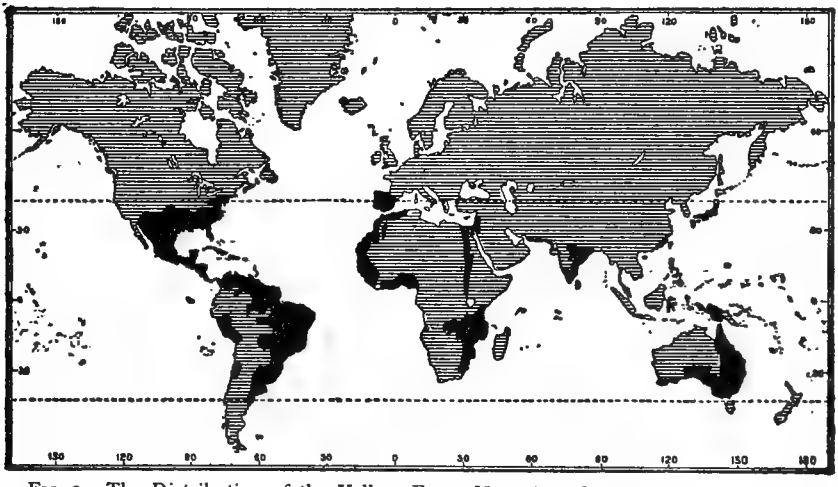

FIG. 3.—The Distribution of the Yellow Fever Mosquito (*Stegomyia fasciata* Fab.).

in *Central* and *South America* and the West Indies, which regions seem to be its original home. It is abundant in *Australia*, and passes up the East Indies to join the others at Malaya. Most oceanic islands also have this insect in their fauna. There is little doubt that the Central American States and West Indies are the home of *Stegomyia fasciata*, and that it has spread out from this area by artificial means. This is easily explained by the fact that we frequently find the Tiger Mosquito on board ship, and often in considerable numbers. In the old days they probably bred in the ship's tanks, just as we find them doing now on the Nile steamers. Coming to port, a certain number may fly to land, and so set up a new colony. In this respect

we may note that in some countries—Malaya, for instance—they so far only occur in the ports and along the littoral. Their further advance inland is more gradual. This takes place mainly along the river courses by boats and along the rail tracts. In both river steamers and trains we often find this mosquito in numbers. Not only by artificial means do we get a most annoying insect spread, but there is the concomitant danger of yellow fever as long as we have the insect, that carries it, present. Luckily this mosquito is found breeding almost exclusively in and around houses and dwelling-places, and so can easily be destroyed.

In a similar way the Brown Household Mosquito (*Culex fatigans*, Wiedemann) seems to have been distributed. Skuse tells us that its advance inland in Australia has followed the opening of the railways. We know, as with the former insect, that it is often a fellow-passenger on board ship. Both these insects have nevertheless their finality of distribution, and we find that they will not live if they reach farther than somewhere near 48° north and south of the Equator (under normal conditions). They have both spread outwards from the warmer regions.

On the other hand, by similar artificial means the Brown Spotted-Mosquito (*Theobaldinella spathipalpis*, Rondani) of Southern Europe has spread in the reverse way, and we now find it at Khartoum and at the Cape. We know of no records until the last few years of it at the Cape, its advent being probably due to the large number of transports running there during the recent war. This species is found in abundance at Teneriffe and other islands on the way to Africa.

The instances quoted here are merely a few which show from recent observations how insect enemies may and have been distributed from country to country, and how they may or may not increase to such an extent that they even out-rival the damage they do in their native lands. To repeat once more, "One can never prophesy how an introduced insect may act in its new home." It is therefore essential to the well-being of mankind that this insect dispersal by artificial means should be dealt with universally, in regard to those pests which attack farm and garden produce, stores, stock, and man, to save further loss and danger.